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Central bank independence and public debt policy

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Abstract

The various proposals for the institutional design of the European Monetary Union have drawn fresh attention to the link between monetary and public debt policies. This paper explores the strategic interaction between fiscal authorities setting public debt and the central bank controlling monetary policy. In the absence of political distortions, an optimally designed conservative, independent central bank is sufficient to establish the second best. In the presence of political distortions or with coordination of monetary and fiscal policy, however, also a debt target is needed.

Keywords: Central bank independence; Policy coordination; Price stability weights; (optimal) Debt targets; Strategic debt management; Political distortions; Optimal preferences

JEL classification: E52; E58; E61; E62

1. Introduction

The fiscal convergence criteria for entrance into the European Monetary Union (EMU) require several potentially participating countries to substantially cut their fiscal debts and deficits, in part, to enhance the credibility of

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the monetary policy of the European Central Bank (ECB). Indeed, the fiscal convergence criteria and the various proposals for constraints on fiscal policies within the EMU have drawn fresh attention to the link between monetary and public debt policies. By exploring the strategic relationship between the fiscal authorities setting debt policy and the central bank controlling monetary policy, this paper contributes to the debate on the institutional design of the European Monetary Union (EMU).

In order to shed light on this debate, we link two strands of the literature. One perspective views public debt as a strategic instrument of the fiscal policy makers. In particular, Persson and Svensson (1989), Aghion and Bolton (1989) and Alesina and Tabellini (1990) focus on public debt as an instrument of the current governments to impact fiscal policies selected by future governments. A second perspective explores the role of debt policy in affecting discretionary monetary policies. Obstfeld (1991a, b) and Jensen (1994) show how governments may want to accumulate public assets in order to reduce the incentive to generate unanticipated inflation. They assume that a single policy maker controls both fiscal and monetary policy. In most European countries, however, monetary policy is delegated to an independent central bank. Within an EMU, the independent European Central Bank will conduct monetary policy. Accordingly, we explore public debt accumulation as the outcome of the strategic interaction between separate monetary and fiscal authorities. In particular, we incorporate endogenous debt accumulation in Alesina and Tabellini's (1987) model of a policy game between a government controlling fiscal policy and a central bank setting monetary policy.[1]

We start off by studying public debt policy when monetary and fiscal authorities are benevolent, can commit to announcements of future inflation, and coordinate their policies (cf. Bryson et al. 1993; Bryson, 1994). This case is termed second best because it yields the highest level of social welfare in the absence of lump-sum taxes.[2] It thus provides a natural benchmark for the rest of the paper.

We then proceed by dropping the rather unrealistic assumption of commitment. Compared to the case with commitment, discretionary coordinated policy making induces additional accumulation of public assets. Intuitively, by enhancing the credibility of monetary policies aimed at price stability, assets

[1] For the strategic interaction between monetary and fiscal policies in a closed economy, see also Sargent and Wallace (1981), Tabellini (1986), Debelle (1993), Levine and Pearlman (1992), Levine (1993), Debelle and Fischer (1994), Levine and Brociner (1994) and Krichel, et al. (1994). Bryson et al. (1993) and Bryson (1994) investigate these issues in the context of an open economy.

[2] In the presence of lump-sum taxes, the welfare level can be even higher. This is the first-best equilibrium.

accumulation acts as a substitute for commitment (see also Obstfeld, 1991a, b; Jensen, 1994).[3]

The welfare losses associated with discretionary policy making can be reduced by decentralizing monetary policy to an independent, conservative central bank that does not coordinate its policies with the fiscal policy makers. We show that the resulting strategic interaction between the fiscal and monetary authorities may boost the accumulation of public debt. In particular, if the central bank is too conservative from the ex ante perspective of the fiscal authority, the latter accumulates additional debt to encourage the central bank to produce higher inflation. This result contrasts with the case of coordinated policy making in Obstfeld (1991a, b) and Jensen (1994), when discretionary policy making unambiguously reduces public debt. In the absence of coordination, we arrive at a similar result if the first-period fiscal authorities do not find the central bank conservative enough. In that case, the fiscal authorities strategically reduce debt accumulation to induce the central bank to decrease inflation in the future. In this way, rather paradoxically, the discretionary equilibrium may yield a better performance in terms of long-run price stability than would the second-best equilibrium. This result is closely related to Sargent and Wallace (1981) who show that, with an exogenously given fiscal policy, tighter monetary control in the short run may boost inflation in the longer run. We demonstrate how this result may continue to hold in an explicit game-theoretic framework in which both monetary and fiscal policy are endogenously determined.

The strategic interaction between monetary and fiscal authorities in a dynamic framework allows us to address normative issues. In particular, the inability to commit gives rise to two additional sources of welfare losses compared to the second-best equilibrium. One, familiar, source is intratemporal: the monetary authorities attempt in vain to alleviate distortions in the real economy by stimulating output through unanticipated inflation. The other, less familiar, source of welfare loss produced by discretionary policy involves the intertemporal distribution of distortionary losses. From the perspective of a discretionary policy maker who sets policy in the first period, first-period expectations are pre-determined. The corresponding expectations in the second period, in contrast, still have to be determined and may, thus, be affected by policy. This induces the policy maker to use unanticipated inflation in the first period, thereby in effect exploiting the exogenous first-period inflation expectations, to impact inflation expectations in the second period. However, in equilibrium, the private sector correctly anticipates these incentives facing policy

[3]In Obstfeld (1991a, b), time inconsistency originates in money demand being dependent on expected inflation. Our model as well as Jensen's (1994), in contrast, is in the tradition of Barro and Gordon (1983). Hence, nominal wages are the source of the time-consistency problem.

makers to use first-period unanticipated inflation in this fashion. In a dynamic setting, therefore, the inability to commit yields not only additional intra- but also intertemporal welfare losses.

These welfare losses can be eliminated by properly designed institutions. This is easiest if authorities do not coordinate. In that case, and in contrast to the case with coordination, adjusting the preferences of the central bank is sufficient to deal with the distortions arising from the inability to commit.

Political distortions may cause the preferences of the fiscal authorities to depart from those of society. In particular, fiscal authorities may be myopic in the sense that they are more impatient than society. Alternatively, they may be opportunistic in that they care less about price stability than society does. In the presence of these political distortions, an optimally designed, conservative independent central bank is no longer sufficient to reach the second best. Intuitively, changing monetary institutions is not the proper instrument to deal with imperfect fiscal institutions. Indeed, to achieve the second best in the presence of political distortions, both monetary and fiscal institutions should be dealt with. Properly adjusting the price stability weight of the central bank removes the distortions due to the inability to commit. Debt ceilings, which have recently been advocated in the United States and Europe, avoid excessive debt accumulation by myopic or opportunistic fiscal authorities.

If fiscal instruments, including debt ceilings, are not available, monetary institutions have to deal with fiscal imperfections. If fiscal authorities are more impatient than society, for example, the decentralized central bank should be made less conservative than when in the absence of political distortions. Accordingly, monetary policy is distracted from its primary mission of price stability. This may explain why central bankers have been strong advocates of ceilings on public debt as entrance criteria for the EMU.

The remainder of the paper is organized as follows. Section 2 sets out our model. Section 3 analyzes the benchmark of coordination by benevolent policy makers under commitment, which yields the second best. Section 4 relaxes the assumption of commitment. Decentralized monetary policy making under discretion is explored in Section 5. Section 6 studies how, in the absence of commitment and coordination, institutions can be designed so as to achieve the second best. Finally, Section 7 concludes the paper.

2. The model

This section formulates a two-period model. This model is based on Alesina and Tabellini (1987) but extended with public debt accumulation. We formulate a game between three players: a union representing workers and two policy authorities, namely a fiscal authority (the government) and a monetary authority (the central bank).

2.1. Output and preferences

Workers aim solely at a target real wage rate, the logarithm of which we normalize to zero.[4] Therefore, the (log) of the nominal wage rate in period t is set equal to the (rationally) expected (log) price level in period t, p_t^e. Nominal wage contracts are concluded before policy is selected. Unions thus act as Stackelberg leaders vis-à-vis policy makers.

Output is given by $Y_t = L_t^\eta$ $(0 < \eta < 1)$, where L_t is labor, and is taxed at a rate τ_t. The representative firm selects employment so as to maximize profits $P_t L_t^\eta (1 - \tau_t) - W_t L_t$, where P_t and W_t denote the price level and the wage rate, respectively. Hence, (log) output is given by $y_t = (\eta/(1-\eta))(\pi_t - \pi_t^e - \tau_t + \log \eta)$, where π_t is the inflation rate and π_t^e the expected inflation rate. For convenience, we normalize output by subtracting the constant $(\eta/(1-\eta))\log \eta$ from y_t. Hence, normalized output, x_t, amounts to

$$x_t = v(\pi_t - \pi_t^e - \tau_t), \quad v \equiv \eta/(1-\eta). \tag{1}$$

Without tax distortions, $x_t = 0$ in a rational expectations equilibrium (where inflation is anticipated, i.e. $\pi_t = \pi_t^e$; see (1)). In addition to distortionary output taxes, we allow for other, non-tax, distortions due to, for example, union power in the labor market or monopoly power in commodity markets. The first-best output level, i.e. output with neither tax nor non-tax distortions, is denoted by $\tilde{x}_t$. Thus, $\tilde{x}_t > 0$ measures the non-tax distortions and can be interpreted as an *implicit* tax on output. In fact, by offsetting the implicit output tax, an output subsidy $(\tau_t = -\tilde{x}_t/v)$ can raise output towards its first-best level $\tilde{x}_t$.

Society features a social welfare function that differs from the objectives of the unions because it accounts for the preferences of both workers and non-workers. In particular, society's preferences, defined over inflation, output and public spending, are represented by the following loss function:

$$V_S = \frac{1}{2} \sum_{t=1}^{2} \beta_S^{t-1} [\alpha_{\pi S} \pi_t^2 + (x_t - \tilde{x}_t)^2 + \alpha_{gS}(g_t - \tilde{g}_t)^2],$$

$$0 < \beta_S \leq 1, \; \alpha_{\pi S}, \alpha_{gS} > 0. \tag{2}$$

[4]Following Alesina and Tabellini (1987), we may assume that nominal wages are set by a union. Alternatively, we can assume that small agents without market power conclude nominal wage contracts (in that case non-tax distortions on the labor market would be absent, i.e. $\tilde{x}_t = 0$, see below). The crucial assumptions underlying our main results are that nominal wages are fixed when monetary policy is selected and that lump-sum taxes are not available. These two assumptions imply that policy makers face the temptation to use unanticipated inflation to alleviate the tax distortions arising from the need to finance public spending and to pay off the initial public debt.

Welfare losses increase in the deviations of inflation, (log) output and government spending (g_t is government spending as a share of non-distortionary output) from their targets (or first-best levels or 'bliss points'). The target level of inflation corresponds to price stability. The non-distortionary output level, $\tilde{x}_t$, represents the bliss point for output. The first-best level of government spending, $\tilde{g}_t$, can be interpreted as the optimal share of non-distortionary output to be spent on public goods if (non-distortionary) lump-sum taxes would be available (see Debelle and Fischer, 1994). The parameters $\alpha_{\pi S}$ and α_{gS} correspond to the weights of the price stability and government spending objectives, respectively, relative to the output objective. The limiting case of $\alpha_{gS} \to \infty$ corresponds to the situation in which government spending is exogenously fixed at $\tilde{g}_t$. Finally, β_S denotes society's subjective discount factor.

The government controls the instruments of fiscal policy, i.e. taxes, public spending, and public debt. The inflation rate is set by a central bank, which controls monetary policy. Preferences of the fiscal and monetary authorities are likewise given by, respectively,

$$V_F = \frac{1}{2}\sum_{t=1}^{2} \beta_F^{t-1}[\alpha_{\pi F}\pi_t^2 + (x_t - \tilde{x}_t)^2 + \alpha_{gS}(g_t - \tilde{g}_t)^2],$$

$$0 < \beta_F \leq 1 \text{ and } \alpha_{\pi F} > 0 \tag{3}$$

and

$$V_M = \frac{1}{2}\sum_{t=1}^{2} \beta_S^{t-1}[\alpha_{\pi M}\pi_t^2 + (x_t - \tilde{x}_t)^2 + \alpha_{gS}(g_t - \tilde{g}_t)^2], \quad \alpha_{\pi M} > 0. \tag{4}$$

The price stability weights of the two policy authorities do not have to coincide. Moreover, these weights can differ from society's price stability weight. A policy maker with a larger price stability weight will be termed to be *more conservative*. Political distortions are present if the government's preferences depart from those of society. In particular, a government that cares less about inflation than society does (i.e. $\alpha_{\pi F} < \alpha_{\pi S}$) is called *opportunistic*. A government is *myopic* if its subjective discount factor is lower than that of society (i.e $\beta_F < \beta_S$). Such a high rate of time preference may be due to, for example, a high probability of being voted out of office at the end of the first period.[5]

[5]Cukierman, Edwards and Tabellini (1992) show explicitly how the degree of political instability affects the effective rate of time preference of the government in a model in which the choice of the efficiency of the tax structure plays a similar strategic role as debt does in this paper.

2.2. The government financing requirement

The government budget constraint in period t ($t = 1, 2$) is given by (see the appendix),

$$g_t + (1 + \rho)d_{t-1} = \tau_t + \kappa\pi_t + d_t, \quad t = 1, 2, \tag{5}$$

where ρ denotes the (constant) real interest rate[6] and τ_t and $\kappa \geq 0$ represent, respectively, revenue from distortionary taxation and real money holdings as shares of (non-distortionary) output. Seigniorage revenues equal $\kappa\pi_t$. Whereas Alesina and Tabellini (1987) and Debelle (1993) set $\kappa = 1$, we allow κ to differ from unity. A non-unitary value for κ will play an important role in the subsequent analysis. The amount of public debt carried over from the previous period is given by d_{t-1}, while d_t denotes newly issued public debt. All public debt is indexed[7] and matures after one period. Moreover, all debt is paid off at the end of the second period (i.e. $d_2 = 0$).

For later convenience, we rewrite (5) to give the *government financing requirement*:

$$\mathrm{GFR}_t \equiv \tilde{K}_t + (1 + \rho)d_{t-1} - d_t = [\tau_t + \tilde{x}_t/v] + \kappa\pi_t + [\tilde{g}_t - g_t],$$

where

$$\tilde{K}_t \equiv \tilde{g}_t + \tilde{x}_t/v. \tag{6}$$

The government financing requirement (GFR_t) amounts to the government spending target $\tilde{g}_t$, a labor subsidy aimed at offsetting the implicit tax on output, $\tilde{x}_t/v$, and the cost of servicing outstanding public debt net of newly issued debt, $(1 + \rho)d_{t-1} - d_t$. The last term on the right-hand side of (6) represents the sources of finance: explicit and implicit tax revenues, $\tau_t + \tilde{x}_t/v$, seigniorage revenues, $\kappa\pi_t$, and the *(public) spending gap*, $\tilde{g}_t - g_t$.

Taking the discounted (to period one) sums of the left- and right-hand sides of (6) (for $t = 1, 2$), we obtain the *intertemporal government financing requirement*,

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[6] This is the rate of return on public debt required by a risk-neutral investor who has an outside investment opportunity paying a real rate of return ρ.

[7] In the presence of non-indexed debt, the ex post real interest rate would be given by $\rho - (\pi_t - \pi_t^e)$. While results would be unaffected in the absence of coordination, centralized policy makers would face an additional incentive for a surprise inflation (in absence of commitment). The reason is that the monetary authority would take into account the effect of a surprise inflation on the ex post real value of the debt and thus on the government budget constraint. A full analysis of these issues is beyond the scope of this paper.

$$\tilde{F} \equiv (1+\rho)\, d_0 + \tilde{K}_1 + \tilde{K}_2/(1+\rho)$$

$$= \sum_{t=1}^{2} (1+\rho)^{-(t-1)}[(\tau_t + \tilde{x}_t/v) + \kappa\pi_t + (\tilde{g}_t - g_t)]. \tag{7}$$

3. The second best: Policy coordination by benevolent authorities under commitment

In the absence of lump-sum taxes, the highest welfare level is achieved when policy makers are benevolent (i.e. they represent the preferences of society), coordinate their policies, and are able to commit to their policy announcements. In particular, authorities are able to bind themselves to the inflation rate that is announced at the beginning of each period, before wages are set. To derive this second-best equilibrium formally, we impose $\alpha_{\pi F} = \alpha_{\pi M} = \alpha_{\pi S}$ and $\beta_F = \beta_S$ and minimize a weighted average of the loss functions (3) and (4) subject to (1) and (5). The relative weights attached to the objective functions of the two authorities do not affect the resulting equilibrium because the objective functions of the two authorities coincide. We proceed by solving the model backwards over time.[8] In particular, for a given d_1 and under the condition that $\pi_2^e = \pi_2$, the second-period policy choices and the equilibrium welfare losses are derived. Subsequently, imposing $\pi_1^e = \pi_1$, we compute the first-period policies (including d_1), assuming that the second-period policies will be selected optimally.

3.1. Public debt

The optimal amount of debt equates the marginal benefits of issuing more debt in the first period to the (discounted) marginal costs. These costs take the form of larger distortionary losses in the second period on account of the higher debt servicing costs. The second-best level of debt is

$$d_1^C = \frac{[\tilde{K}_1 + (1+\rho)d_0 - \tilde{K}_2] + [(1-\beta_S^*)\tilde{K}_2]}{\beta_S^*(1+\rho)+1}, \quad \text{where } \beta_S^* \equiv \beta_S(1+\rho). \tag{8}$$

The right-hand side of (8) reveals the two determinants of optimal debt accumulation. The term $[\tilde{K}_1 + (1+\rho)d_0 - \tilde{K}_2]$ in the numerator represents the so-called *smoothing effect*. This effect raises (reduces) d_1^C whenever the exogenous component of the government financing requirement in the first

[8] A technical appendix with the details of the derivations is available from the authors upon request.

period, $\tilde{K}_1 + (1+\rho)d_0$, exceeds (falls short of) the exogenous component of the government financing requirement in period two, $\tilde{K}_2$. The term $[(1-\beta_S^*)\tilde{K}_2]$ in the numerator stands for the *intertemporal substitution effect*. This effect raises (reduces) public debt if impatience as measured by the subjective rate of time preference exceeds (falls short of) the rate of return on assets.

3.2. *Inflation, taxes, and public spending*

The policy outcomes are contained in Table 1. The shares of the government financing requirement absorbed by seigniorage ($\kappa\pi_t$), the sum of explicit and implicit taxes ($\tau_t + \tilde{x}_t/v$) and the public spending gap ($\tilde{g}_t - g_t$) are the same in both periods. If $\beta_S^* = 1$, the government financing requirements are perfectly smoothed out over the two periods. Hence, inflation, total taxes and the public

Table 1
Policy outcomes under various regimes

Policy variable	First period ($r = C, D$ or N)	Second period ($r = C, D$ or N)
$\kappa\pi_t$	$\omega_{\pi r}\beta_r^*\delta_r\tilde{F}$	$\omega_{\pi r}\delta_r\tilde{F}$
$\tau_t + \tilde{x}_t/v$	$\omega_{\tau r}\beta_r^*\delta_r\tilde{F}$	$\omega_{\tau r}\delta_r\tilde{F}$
$\tilde{g}_t - g_t$	$\omega_{gr}\beta_r^*\delta_r\tilde{F}$	$\omega_{gr}\delta_r\tilde{F}$
d_1^r	$\dfrac{\tilde{K}_1 + (1+\rho)d_0 - \tilde{K}_2 + (1-\beta_r^*)\tilde{K}_2}{\beta_r^*(1+\rho)+1}$	N.A.

Regime (r)	$\omega_{\pi r}$	$\omega_{\tau r}$	ω_{gr}	β_r^*
C	$\dfrac{\kappa^2/\alpha_{\pi S}}{C}$	$\dfrac{1/v^2}{C}$	$\dfrac{1/\alpha_{gS}}{C}$	$\beta_C^* \equiv \beta_S^*$
D	$\dfrac{\kappa(\kappa+1)/\alpha_{\pi A}}{D}$	$\dfrac{1/v^2}{D}$	$\dfrac{1/\alpha_{gS}}{D}$	$\beta_D^* \equiv \beta_S^* D^*/D$
N	$\dfrac{\kappa/\alpha_{\pi M}}{N}$	$\dfrac{1/v^2}{N}$	$\dfrac{1/\alpha_{gS}}{N}$	$\beta_N^* \equiv \beta_F^* N^*/N$

Note: 1. Subscript r ($= C, D$ or N) indicates the policy regime: C = second best (Coordination of benevolent authorities under commitment), D = coordination under Discretion, N = decentralized monetary policy under discretion ("Non-coordination").
2. N.A. = not applicable.
3. Note that $\omega_{\pi r} + \omega_{\tau r} + \omega_{gr} = 1$, for $r = C, D$ or N.
4. $\beta_F^* \equiv \beta_F(1+\rho)$, $\tilde{F} \equiv \tilde{K}_1 + (1+\rho)d_0 + \tilde{K}_2/(1+\rho)$, $\tilde{K}_t \equiv \tilde{g}_t + \tilde{x}_t/v$,
$\delta_r \equiv (1+\rho)/[\beta_r^*(1+\rho)+1]$, $C \equiv \kappa^2/\alpha_{\pi S} + 1/v^2 + 1/\alpha_{gS}$,
$D \equiv \kappa(\kappa+1)/\alpha_{\pi A} + 1/v^2 + 1/\alpha_{gS}$, $D^* \equiv (\kappa+1)^2/\alpha_{\pi A} + 1/v^2 + 1/\alpha_{gS}$,
$N \equiv \kappa/\alpha_{\pi M} + 1/v^2 + 1/\alpha_{gS}$, $N^* \equiv \alpha_{\pi F}/\alpha_{\pi M}{}^2 + 1/v^2 + 1/\alpha_{gS}$.

Table 2
Society's welfare losses under various regimes

Policy regime	Welfare loss
C	$\left(\frac{1}{2C}\right)[\delta_C^2((\beta_S^*)^2+\beta_S)]\tilde{F}^2$
D	$\left(\frac{(\kappa+1)^2\alpha_{\pi S}/\alpha_{\pi A}^2+1/v^2+1/\alpha_{gS}}{2D^2}\right)[\delta_D^2((\beta_D^*)^2+\beta_S)]\tilde{F}^2$
N	$\left(\frac{\alpha_{\pi S}/\alpha_{\pi M}^2+1/v^2+1/\alpha_{gS}}{2N^2}\right)[\delta_N^2((\beta_N^*)^2+\beta_S)]\tilde{F}^2$

Note: For definitions, see Table 1.

spending gap are constant over time. If $\beta_S^* < 1$, first-period welfare losses are relatively important compared to the return on assets. Accordingly, inflation, seigniorage, taxes and the government spending gap rise over time.

3.3. *Welfare*

Substitute (1) into (2) and impose $\pi_t^e = \pi_t$ $(t = 1, 2)$. Then, substituting the policy outcomes from Table 1 into the resulting expression yields society's second-best welfare loss (see Table 2). The term $(1/2C)^{-1}$ in Table 2 stems from the *intra*temporal distribution of distortionary losses over the various instruments (seigniorage, taxes and the spending gap) and is, therefore, called the *intratemporal loss factor*. The term $\delta_C^2((\beta_S^*)^2 + \beta_S)$ originates in the *inter*temporal distribution of distortionary losses and, hence, depends on debt accumulation. We call it the *intertemporal loss factor*.

4. Policy coordination without commitment

This section drops the rather unrealistic assumption that policy makers are able to commit to their policy announcements. In each period, the private sector acts as a Stackelberg leader in concluding nominal wage contracts. Accordingly, when selecting discretionary policies in the first period, policy makers take inflation expectations for that period as exogenously given. Expectations about second-period inflation, in contrast, still need to be formed and can thus be affected by first-period policy. Indeed, as we will discuss below, the fiscal authorities employ debt policy to impact second-period inflation expectations.

We continue to assume that the fiscal authority is benevolent in that its preferences coincide with society's preferences. Rogoff (1985) has shown that, in the absence of commitment, society can raise its welfare level by delegating discretionary monetary policy to a central bank that is more conservative than is society. Accordingly, we allow the degree of inflation aversion of the central bank to differ from that of society. The two policy makers continue to coordinate their policies. The relative weights attached to the objective functions of the fiscal and monetary authorities are given by, respectively, $1-\mu$ and μ (where $0<\mu<1$).

4.1. Public debt

The equilibrium level of public debt is

$$d_1^{\mathrm{D}} = \frac{[\tilde{K}_1 + (1+\rho)d_0 - \tilde{K}_2] + [(1-\beta_{\mathrm{D}}^*)\tilde{K}_2]}{\beta_{\mathrm{D}}^*(1+\rho)+1}, \tag{9}$$

where $\beta_{\mathrm{D}}^* \equiv \beta_{\mathrm{S}}^* D^*/D$, $D \equiv \kappa(\kappa+1)/\alpha_{\pi\mathrm{A}} + 1/v^2 + 1/\alpha_{g\mathrm{S}}$ and $D^* \equiv (\kappa+1)^2/\alpha_{\pi\mathrm{A}} + 1/v^2 + 1/\alpha_{g\mathrm{S}}$, and where $\alpha_{\pi\mathrm{A}} \equiv (1-\mu)\alpha_{\pi\mathrm{S}} + \mu\alpha_{\pi\mathrm{M}}$ represents the weighted average of the degrees of inflation aversion of the two policy makers. We will refer to β_{D}^* as the *effective* discount factor of the government. An increase in this factor reduces public debt.

Comparing (9) with the corresponding expression (8) from the commitment equilibrium, we observe that discretionary debt accumulation is influenced by another effect in addition to the smoothing and intertemporal substitution effects. This so-called *credibility effect* arises from the inability to commit. It is represented by the factor $D^*/D > 1$, which raises the effective discount factor, β_{D}^*, and thus the second-period costs associated with additional debt. Therefore, with coordination, the stock of public debt, d_1, is lower under discretion than under commitment.

The intuition for the lower stock of debt in the discretionary equilibrium is the following (see also Obstfeld, 1991a, b; Jensen, 1994). First-period inflation expectations are perceived as given by policy makers when setting debt policy. Second-period inflation expectations, in contrast, can still be affected. Indeed, policy makers will mitigate the inflationary bias in the second period by reducing the 'stock of credibility problems' in the second period, as measured by the government financing requirement $\tilde{K}_2 + (1+\rho)d_1$. They can do so by cutting public debt. In doing so, they trade off additional distortionary losses in the first period against gains in the credibility of monetary policy in the second period.[9]

[9]If debt would not be indexed (see also footnote 7), the credibility effect would be even stronger and we would expect public debt to be even lower.

4.2. Welfare

An expression for society's welfare loss is contained in Table 2. Just like in the commitment case, the welfare loss can be decomposed into an intratemporal loss factor (the term in the first square brackets) and an intertemporal loss factor (the term in the second square brackets). If both policy makers share the preferences of society (hence, $\alpha_{\pi A} = \alpha_{\pi S}$), both loss factors exceed the corresponding factors under commitment. As regards the *intra*temporal loss factors, we have that

$$\left(\frac{(\kappa+1)^2/\alpha_{\pi S} + 1/\nu^2 + 1/\alpha_{gS}}{2D^2}\right) > \left(\frac{1}{2C}\right), \tag{10}$$

where D is evaluated at $\alpha_{\pi A} = \alpha_{\pi S}$. The additional intratemporal losses under discretion originate in the incentives facing policy makers to employ inflation surprises as an instrument to alleviate tax distortions. The private sector correctly anticipates these incentives to exploit nominal contracts. In this way, the interaction between the policy makers, who cannot commit to a low-inflation policy, and the public, which correctly anticipates inflation, generates an inflation bias.

Wheras the additional intratemporal welfare losses due to discretion are relatively familiar from the literature, the additional intertemporal welfare losses are less well known. The following inequality indicates that discretionary policy produces a suboptimal intertemporal allocation if both authorities are benevolent:

$$\delta_D^2((\beta_D^*)^2 + \beta_S) > \delta_C^2((\beta_S^*)^2 + \beta_S), \tag{11}$$

where β_D^* and δ_D are defined in Table 1. The intuition for the additional intertemporal welfare losses produced by discretion is as follows. As explained above, policy makers try to rely relatively heavily on first-period financing, among other things in the form of unanticipated inflation, in order to build up public assets, thereby decreasing inflation expectations in the second period. However, in equilibrium, the private sector correctly anticipates the policy makers' incentives to use inflation surprises in the first period in this way. Hence, the discretionary equilibrium suffers from an asset bias associated with an excessive reliance on first-period sources of financing. From society's point of view, inflation expectations are endogenous in not only the second period but also the first period. Thus, as under commitment, only smoothing of distortions and intertemporal substitution effects (and not the credibility effect) should determine optimal debt policy.

4.3. Optimal institutions

To establish the second best, additional distortions should be introduced to offset both the *intra*temporal and the *inter*temporal misallocation of distortionary losses. The optimal intratemporal trade-off is attained if the central bank's price stability weight is set as follows:

$$\alpha_{\pi M} = \alpha_{\pi S}(1 + 1/(\mu\kappa)), \tag{12}$$

so that $\alpha_{\pi A} = \alpha_{\pi S}(\kappa + 1)/\kappa$. This value of $\alpha_{\pi A}$ reduces the intratemporal loss factor under discretion to the corresponding factor under the second best, $(2C)^{-1}$. The central bank has to be made more conservative than society (i.e. more inflation averse as measured by a higher value of $\alpha_{\pi M}$) in order to offset the inflation bias due to discretion (see Rogoff, 1985). Moreover, in order to obtain the appropriate average price stability weight for the policy makers, the adjustment of $\alpha_{\pi M}$ needs to be larger, lower the relative weight attached to the central bank's objective function.

Policy makers still do not face the correct incentives in setting debt policy, even if the degree of inflation aversion of the central bank is corrected according to (12). Intuitively, with coordinated policymaking, the central bank impacts debt policy. Accordingly, the adjustment of the preferences of the central bank distorts intertemporal policy decisions (that is, it affects β_D^* through the factor D^*/D). In particular, given that it is now more averse to inflation than is society, the central bank still perceives an inflationary bias in the second period, even though inflation is optimal from the point of view of society. Hence, policy makers accumulate additional assets to bring inflation performance in the second period more in line with the adjusted monetary preferences.

One way to correct the intertemporal trade-off is to impose an optimal debt target. The Maastricht Treaty includes ceilings on public debt as entrance requirements for participation in an EMU. Furthermore, proposals have been put forward in the United States to balance the federal budget. Suppose that, for example, the legislature (which represents the social preferences) imposes a target $\hat{d}_1$ for the amount of debt that should be issued in the first period. In that case, policy makers solve two single-period problems with exogenous government financing requirements $\tilde{K}_1 + (1+\rho)d_0 - \hat{d}_1$ and $\tilde{K}_2 + (1+\rho)\hat{d}_1$ in the first and second period, respectively. Given that inflation, taxes and public spending are selected optimally in each period, society's discounted welfare loss amounts to

$$\left(\frac{(\kappa+1)^2\alpha_{\pi S}/\alpha_{\pi A}^2 + 1/\nu^2 + 1/\alpha_{gS}}{2D^2}\right)$$

$$((\tilde{K}_1 + (1+\rho)d_0 - \hat{d}_1)^2 + \beta_S(\tilde{K}_2 + (1+\rho)\hat{d}_1)^2). \tag{13}$$

Society's optimal debt target minimizes this expression and is thus given by

$$\hat{d}_1^{\mathrm{opt}} = \frac{\tilde{K}_1 + (1+\rho)d_0 - \tilde{K}_2 + (1-\beta_S^*)\tilde{K}_2}{\beta_S^*(1+\rho)+1}, \tag{14}$$

which equals d_1^C, the amount of debt under the second best. The optimal debt target is chosen independently from the optimal inflation weight (12). Therefore, the combination of an optimal inflation weight (12), which minimizes the intratemporal loss, and an optimal debt target (14), which minimizes the intertemporal loss, yields the second best (expression (13) reduces to the expression for the second-best welfare loss – see Table 2).

5. Decentralized policy making with an independent central bank

From now on, we assume that fiscal and monetary policy makers do not coordinate their policy decisions. The government selects taxes, public spending, and public debt, while taking the current inflation rate as given. The central bank, which is unable to commit, selects the inflation rate, taking the fiscal policy of the government as given. Moreover, as an independent entity, it ignores the impact of monetary policies on the government budget constraint (see Debelle, 1993; Debelle and Fischer, 1994).

We allow the preferences of policy makers to diverge and to differ from the preferences of society, conform (3) and (4). In setting public debt in the first period, the fiscal authority acts as a leader vis-à-vis the three players in the second period. Hence, as we will see below, the fiscal authority may want to employ debt strategically to affect expectations and policy decisions in the second period.

5.1. Public debt accumulation

As before, the government determines the debt level d_1 by equating the marginal benefit and the marginal cost from issuing more debt. This implies

$$d_1^N = \frac{[\tilde{K}_1 + (1+\rho)d_0 - \tilde{K}_2] + [(1-\beta_N^*)\tilde{K}_2]}{\beta_N^*(1+\rho)+1}. \tag{15}$$

Here $\beta_N^* \equiv \beta_F^* N^*/N$ stands for the effective discount factor, where $N \equiv \kappa/\alpha_{\pi M} + 1/v^2 + 1/\alpha_{gS}$, $N^* \equiv \alpha_{\pi F}/\alpha_{\pi M}{}^2 + 1/v^2 + 1/\alpha_{gS}$ and $\beta_F^* \equiv \beta_F(1+\rho)$. Just as in the case with coordination, debt accumulation depends on a smoothing and an intertemporal substitution effect. However, d_1^N may depart from its second-best level for two reasons. The first is that the discount factor of the government (β_F) may differ from society's discount factor (β_S). The second reason is the presence of a so-called *strategic effect*, which arises if $N^*/N \neq 1$. This strategic effect originates in a disagreement between the first-period fiscal authority and the second-period monetary authority about second-period inflation. This disagreement causes the fiscal authority in the first period to employ debt policy strategically in order to affect second-period monetary policy.

For example, if the government cares much less about inflation than the monetary authority does (so that $\alpha_{\pi F}/\alpha_{\pi M} < \kappa$ and, hence, $N^*/N < 1$, thereby reducing β_N^* to below β_F^*), then the government strategically raises debt in the first period in order to encourage the central bank to increase inflation in the second period. Higher debt raises second-period inflation because the associated higher debt servicing costs require higher taxes in the second period. This reduces second-period output, thereby tempting the central bank to boost output through unanticipated inflation. In other words, the government accumulates more debt if a conservative, independent central bank reduces the need to establish the credibility of anti-inflation policies.[10]

If the fiscal authority attaches a sufficiently high priority to price stability, the fiscal authority may actually want to reduce rather than raise debt strategically. In particular, the government decreases debt strategically if the central bank is not conservative enough from the ex ante perspective of the fiscal authority (i.e. $\alpha_{\pi F}/\alpha_{\pi M} > \kappa$ and, hence, $N^*/N > 1$). In that case, second-period monetary policy suffers from an inflation bias from the ex ante (period one) perspective of the government. Therefore, as a substitute for a sufficiently conservative central bank, the government reduces public debt in order to establish the credibility of anti-inflation policies in the second period.

5.2. *Inflation*

In the *static version* of the model, a more conservative central bank unambiguously enhances price stability.[11] In the current dynamic model, the effects on long-term price stability are ambiguous because a more conservative central bank may induce the fiscal authority to issue more debt, thereby increasing inflationary pressures in the long run. Indeed, an increase in $\alpha_{\pi M}$ (for given $\alpha_{\pi F} > 0$) produces not only an *intra*temporal shift away from inflation towards higher taxes and lower public spending (as in the static model), but also an *inter*temporal shift in the financing requirement. In particular, if $\alpha_{\pi M}$ is not too high, an increase in $\alpha_{\pi M}$ reduces β_N^*, thereby shifting distortionary losses towards the second period and thus putting upward pressure on second-period inflation. This intertemporal effect dominates the intratemporal effect, and, hence, results

[10] The result that a more conservative central bank leads to more debt accumulation appears at other places in the literature (e.g., Tabellini, 1986).

[11] The static version of the model is a one-shot game in which policies are selected for a given initial amount of public debt that has to be paid off in the current period. Hence, the static version of the model corresponds to the second period of the complete model, where d_1 is taken as given.

in a higher second-period inflation only for small values of $\alpha_{\pi M}$. Accordingly, as an instrument to establish long-term price stability, a more conservative central bank is effective only if it is made conservative enough. Intuitively, if the central bank attaches a very high weight to price stability, the fiscal authority does not engage in the strategic accumulation of debt because it knows that the conservative central bank will barely raise second-period inflation in response to a higher second-period financing requirement.[12]

The result that, for relatively low values of $\alpha_{\pi M}$, a more conservative central bank may raise long-run inflation is reminiscent of unpleasant monetarist arithmetic (see Sargent and Wallace, 1981). This arithmetic implies that a tighter short-run monetary policy may boost inflation in the longer run. In contrast to Sargent and Wallace (1981), we derive this result as the time-consistent outcome of an explicitly formulated game between the fiscal and monetary authorities.

To explore this issue further, we compare the inflation performance under uncoordinated discretionary policy making with that under the second best. In doing so, we assume that policymakers share society's preferences (i.e. $\alpha_{\pi M} = \alpha_{\pi F} = \alpha_{\pi S}$ and $\beta_F = \beta_S$). Moreover, from now on, we assume that $\kappa < 1$. This inequality is met for modern economies with efficient means of payment and hence low base-money holdings. Under these assumptions, uncoordinated discretionary policy making produces excessive inflation in the static version of the model. As a direct consequence, the government strategically accumulates assets in order to reduce inflation in the second period. The associated shift in the financing requirement away from the second period may reverse the result from the static model that inflation is lowest under the second best. In particular, second-period inflation is highest under the second best if

$$\left(\frac{\beta_S^*(1+\rho)}{\beta_S^*(1+\rho)+1}\right)\left(\frac{\kappa}{\alpha_{\pi S}(1/v^2+1/\alpha_{gS})}\right) > 1. \tag{16}$$

This inequality is met if the following conditions are met. First, society should be patient, so that a large part of the intertemporal financing requirement must be met in the first period. Accordingly, a small intertemporal shift between the financing requirements exerts a major impact on the second-period inflation rate. The second condition is that the Phillips curve be steep (v is large), so that the strategic asset accumulation is indeed effective in inducing the central bank to reduce the second-period inflation rate. Finally, inflation should account for a relatively large share of the financing requirement, so that a lower second-

[12] Indeed, for high values of $\alpha_{\pi M}$, a further increase in $\alpha_{\pi M}$ raises β_N^*, thereby increasing asset accumulation and thus reinforcing the downward pressure of the intratemporal effect of an increase in $\alpha_{\pi M}$ on second-period inflation. More precisely, one can show that second-period inflation is increasing in $\alpha_{\pi M}$ for $0 < \alpha_{\pi M} < \alpha_{\pi M}^*$, decreasing in $\alpha_{\pi M}$ for $\alpha_{\pi M} > \alpha_{\pi M}^*$ and, hence, reaches a global maximum if $\alpha_{\pi M} = \alpha_{\pi M}^*$, where $\alpha_{\pi M}^* \equiv \{[\beta_F^*(1+\rho)\alpha_{\pi F}]/[(1+\beta_F^*(1+\rho))\,(1/v^2+1/\alpha_{gS})]\}^{1/2} > 0$.

period financing requirement as a result of asset accumulation implies a substantial drop in inflation at that time. A low degree of inflation aversion, a large preference weight for public spending, and large money holdings contribute to such a relatively large share of seigniorage. In this connection, inequality (16) suggests that higher second-period inflation under the second best (i.e. unpleasant monetarist arithmetic) is unlikely to occur in modern economies with small money holdings.

5.3. *Welfare*

To interpret the expression for society's welfare losses contained in Table 2, we continue to assume that policy makers share society's inflation aversion (i.e. $\alpha_{\pi \mathrm{M}} = \alpha_{\pi \mathrm{F}} = \alpha_{\pi \mathrm{S}}$). Accordingly, inflation is excessive because the distortion due to discretion (i.e. the self-defeating incentive facing discretionary monetary policy makers to boost output through unanticipated inflation) dominates the distortion due to uncoordinated decision making. The latter distortion arises because the independent central bank ignores the beneficial social role of inflation in generating additional seigniorage revenues.

The inability to commit results in two sources of additional welfare loss compared to the second best. The first source, the suboptimal *intra*temporal allocation of distortionary losses, stems from inflation being too high compared to the socially optimal inflation rate. Indeed, the intratemporal loss factor under decentralization exceeds the corresponding factor under the second best:

$$\left(\frac{\alpha_{\pi \mathrm{S}}/\alpha_{\pi \mathrm{M}}^2 + 1/v^2 + 1/\alpha_{g\mathrm{S}}}{2N^2}\right) = \left(\frac{1/\alpha_{\pi \mathrm{S}} + 1/v^2 + 1/\alpha_{g\mathrm{S}}}{2N^2}\right) > \left(\frac{1}{2C}\right). \tag{17}$$

The second source, the suboptimal *inter*temporal allocation of distortions, originates in the strategic use of the debt instrument. The intertemporal loss factor is also higher under decentralization than under the second best:

$$\delta_{\mathrm{N}}^2((\beta_{\mathrm{N}}^*)^2 + \beta_{\mathrm{S}}) > \delta_{\mathrm{C}}^2((\beta_{\mathrm{S}}^*)^2 + \beta_{\mathrm{S}}), \tag{18}$$

where δ_{N} is defined in Table 1.

6. Optimal institutions under decentralization

6.1. *Optimal institutions in the absence of political distortions*

This section investigates how properly designed institutions may replicate the second-best equilibrium. Allowing the preferences of the monetary authority to depart from societies' preferences may enhance welfare by offsetting the distortions associated with discretionary policy making (see Rogoff, 1985). In particular, in the absence of political distortions (so that the government shares society's preferences), a *necessary* and *sufficient* condition for establishing the second best (as can be checked from Tables 1 and 2) is that the price stability weight of the decentralized, independent central bank be set according to

$$\alpha_{\pi M} = \alpha_{\pi S}/\kappa. \tag{19}$$

The central bank, thus, must be made more conservative than society (because $\kappa < 1$). Accordingly, an optimally designed decentralized, independent central bank results in an optimal allocation of distortions not only intra- but also intertemporally. Intuitively, the incentive facing the first-period fiscal authority to employ debt policy strategically originates in the inability to commit monetary policy in the second period. If this problem is removed by properly adjusting the preferences of the central bank, the first-period fiscal authority no longer perceives any need to use debt policy strategically in order to move second-period monetary policy closer to the social optimum. Indeed, correcting monetary policy preferences is a direct way to eliminate the distortions due to the inability to commit.

The result that, in the absence of coordination, adjustments in monetary institutions are sufficient to attain the second best contrasts with coordinated decision making. For this latter case, Section 4 showed that the adjustment in the preferences of the central bank needs to be supplemented by a debt target in order to reproduce the second best. Without coordination, debt targets are not needed if debt policy is determined by fiscal authorities, who represent society's preferences.

6.2. Optimal institutions in the presence of political distortions

Imperfections in the political system may cause the preferences of the fiscal authorities to depart from the preferences of society. In the presence of such political distortions, society can no longer attain the second best by granting the proper degree of conservatism to an independent central bank (i.e. setting $\alpha_{\pi M}$ according to (19)). Intuitively, changing monetary institutions is not the most appropriate instrument to deal with imperfect fiscal institutions.

6.2.1. Monetary and fiscal adjustment

With political distortions involving the preferences of the fiscal authorities in addition to distortions due to the inability to commit monetary policy, the second best can be established only by simultaneously adjusting monetary and fiscal institutions.

The fiscal institution we consider is again a debt target, $d_1 = \hat{d}_1$. With inflation, taxes and public spending selected optimally in each period, society's discounted welfare loss amounts to

$$\left(\frac{\alpha_{\pi S}/\alpha_{\pi M}^2 + 1/v^2 + 1/\alpha_{gS}}{2N^2}\right)((\tilde{K}_1 + (1+\rho)d_0 - \hat{d}_1)^2 + \beta_S(\tilde{K}_2 + (1+\rho)\hat{d}_1)^2). \tag{20}$$

Society's optimal debt target minimizes this expression and is given by $\hat{d}_1^{\text{opt}} = d_1^{\text{C}}$ (see expression (8)). By setting $\hat{d}_1 = \hat{d}_1^{\text{opt}}$ the intertemporal loss is minimized. Accordingly, the combination of an optimal debt target and a decentralized, independent central bank with the appropriate degree of conservatism ($\alpha_{\pi M} = \alpha_{\pi S}/\kappa$) produces the second best.

6.2.2. Monetary adjustment only

Compared to monetary institutions, fiscal institutions are much closer to the day-to-day political process. Therefore, in practice, it may be impossible to deal with political distortions by imposing debt targets. In that case, the second best cannot be attained. Moreover, it is no longer optimal to have monetary institutions aim solely at ensuring the optimal inflation rate. These institutions should also play a role in correcting political distortions.

6.2.2.1. Myopic governments ($\beta_F < \beta_S$). To explore these complications in more detail, we first consider the case in which the government shares society's inflation aversion, but is myopic ($\beta_F < \beta_S$). As argued below, eliminating the inflationary bias of discretionary policy making by properly adjusting the price stability weight of the central bank worsens fiscal distortions due to myopic fiscal policy makers.

The optimal price stability weight of the central bank trades off inter- and intratemporal distortions and lies between the weight $\alpha_{\pi M}^{\text{E}}$ ($0 < \alpha_{\pi M}^{\text{E}} < \alpha_{\pi S}/\kappa$) that minimizes the intertemporal loss factor and the weight $\alpha_{\pi S}/\kappa$ that minimizes the intratemporal loss factor. Accordingly, the central bank should be made less conservative than would be optimal in the case of a benevolent fiscal authority. This would encourage the myopic fiscal authority to restrain debt accumulation strategically so as to enhance the credibility of monetary policy (as explained in Section 5).

In this way, however, the need to alleviate political distortions distracts monetary policy from its primary mission of ensuring price stability. This result may explain why the Delors Report (1989) on the design of monetary and fiscal institutions in the EMU emphasizes the importance of debt ceilings as complementary institutional arrangements to a conservative, independent central bank. Central bankers fear that the governments of the participating countries discount the future too heavily. The optimal debt target (20) would de facto act as a ceiling on public debt.

6.2.2.2. Opportunistic governments ($\alpha_{\pi F} < \alpha_{\pi S}$). Now suppose that the fiscal authority shares society's time preference rate but is opportunistic (i.e. $\alpha_{\pi F} < \alpha_{\pi S}$). Whereas monetary distortions are eliminated (i.e. the intratemporal loss factor is minimized) if $\alpha_{\pi M} = \alpha_{\pi S}/\kappa$, fiscal distortions are taken away (i.e. the intertemporal loss factor is minimized) if $\alpha_{\pi M} = \alpha_{\pi F}/\kappa$. Again, the optimal degree of central bank conservatism trades off additional intra- and intertemporal losses.

7. Conclusions

This paper has explored how monetary policy set by the central bank interacts with public debt policy determined by fiscal authorities. The discussions surrounding the institutional design of the EMU have attracted a lot of attention to this issue. We found that the need to establish the credibility of discretionary monetary policies restrains debt accumulation if policy-makers coordinate their policies. Intuitively, asset accumulation acts as a substitute for commitment to restrictive monetary policies. In the absence of coordination, the conflict between the central bank and the government about future monetary policy induces the government to use debt strategically. In the absence of political distortions (and in contrast to the case of coordination), a properly designed conservative, independent central bank is sufficient to establish the second best. With an opportunistic or myopic government, however, monetary institutions need to be supplemented by an optimal debt target. Without such a debt target, a conservative central bank leads to excessive debt accumulation. This provides a rationale for supplementing an independent European Central Bank that gives priority to price stability with ceilings on public debt in an EMU.

Appendix. Derivation of the government budget constraint

The nominal government budget constraint in period t reads

$$P_t G_t + (1+\rho)P_t D_{t-1} = \tau_t P_t X_t + (M_t - M_{t-1}) + P_t D_t, \tag{A.1}$$

where X_t is the anti-log of x_t, G_t the level of government spending, D_{t-1} the amount of indexed debt issued in period $t-1$ and to be paid off in period t, and M_t the nominal money supply (the numeraire). Assume that $M_t/P_t = \kappa\tilde{X}$, where $\tilde{X}$ is the output level in the absence of any (tax or non-tax) distortions and inflation surprises (conform, for example, Canzoneri, 1995; Alesina and Tabellini, 1987, or Debelle, 1993, who assume that real money holdings are proportional to a policy-independent output measure). Hence, $M_t - M_{t-1} = (P_t - P_{t-1})\kappa\tilde{X}$.

Therefore, dividing both sides of (A.1) by $P_t \tilde{X}$ yields

$$g_t + (1 + \rho)d_{t-1} = \tau_t(X_t/\tilde{X}) + \kappa\pi_t + d_t, \tag{A.2}$$

where $\pi_t \equiv (P_t - P_{t-1})/P_t$. If $\tilde{X}$ is not too different from X_t, which is the case if neither (non-)tax distortions, nor inflation surprises, are too large, then (A.2) is a good approximation to (5).

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